



(Knowledge for Development)

KIBABII UNIVERSITY
UNIVERSITY EXAMINATIONS
2021/2022 ACADEMIC YEAR
FOURTH YEAR FIRST SEMESTER
SPECIAL/SUPPLEMENTARY EXAMINATION
FOR THE DEGREE OF BACHELOR OF SCIENCE
(MATHEMATICS)

COURSE CODE: STA 414

COURSE TITLE: SURVIVAL ANALYSIS

DATE: 16/11/2022

TIME: 8 AM - 10 AM

INSTRUCTIONS TO CANDIDATES

Answer Question One and Any other TWO Questions

TIME: 2 Hours

This Paper Consists of 4 Printed Pages. Please Turn Over.

QUESTION 1: (30 marks)

- (a) The mean is usually used to describe the central tendency of a distribution, but in survival distributions the median is often better, why? (4 marks)

- (b) Given the Survival function,

$$S(t) = \exp(-t^\gamma)$$

Derive the probability density function and the hazard function. (10 marks)

- (c) Consider the generalized form of the weibull distribution with guarantee time, G whose specifications are as follows:

$$G = 0, \quad \lambda = 1, \quad \gamma = 0.5$$

Find,

- (i) Mean and (4 marks)
(ii) Variance survival time (4 marks)
(iii) Let the survival time ,T follow the Weibull distribution with survivorship function, S(t) given as :

$$S(t) = e^{-(\lambda t)^\gamma}$$

Where γ and λ are parameters.

HOW DO YOU ASCERTAIN THE APPROPRIATE WEIBULL FIT FOR A GIVEN SURVIVAL DATA ?

(8 marks)

QUESTION 2 (20 marks)

- (a) What are accelerated failure time models? (2 marks)

- (b) For the i^{th} individual, let values of P variables be $x_{1i}, x_{2i}, \dots, x_{pi}$. If $h_i(t)$ is the hazard function of the i^{th} individual, write an expression relating $h_i(t)$ and the baseline hazard, $h_0(t)$, making cox proportional hazards assumption. (4 marks)

- (c) Illustrate how you would estimate the coefficients of x_{ji} 's in (b) above (8 marks)

- (d) Assume survival time T_i follows exponential distribution with a parameter λ . Under the assumption of right Censored data, obtain the likelihood for the exponential model. (6 marks)

QUESTION 3: (20 marks)

a) Define the following terms as used in Survival analysis :

(i) survivorship function , $S(t)$ (2 marks)

(ii) Hazard function, $h(t)$ (2 marks)

(iii)Probability density function, $f(t)$ (2 marks)

Write down a mathematical expression illustrating how the three functions $S(t)$, $h(t)$ and $f(t)$ are related (3 marks)

State the uses of the survivorship or survival function (3 marks)

b) Illustrate how you would determine that a given data of survival time T come from an exponential distribution (3 marks)

c) i) What do you understand by the term Censoring? (2 marks)

ii) Distinguish right Censoring from left Censoring (3 marks)

QUESTION 4: (20 marks)

Consider the survival data below

Year of follow-up	Number alive at beginning of interval	Number dying in the interval
0 - 1	1100	240
1 - 2	860	180
2 - 3	680	184
3 - 4	496	138
4 - 5	358	118
5 - 6	240	60
6 - 7	180	52
7 - 8	128	44
8 - 9	84	32
≥ 9	52	28

Compute and plot;

(i) The estimated survivorship function (7 marks)

(ii) The probability density function and (7 marks)

(iii) The hazard function (6 marks)

QUESTION 5: (20 marks)

Consider a clinical trial in which 10 lung cancer patients are followed to death. The table is given below.

<u>Time, t (in months)</u>	<u>i</u>
4	1
5	2
6	3
8	4
8	5
8	6
10	7
10	8
11	9
12	10

- (i) Obtain the product limit (PL) estimate of the survivorship function, $\hat{S}(t)$.
Comment on the result so obtained in relation to the corresponding binomial estimate. (12 marks)
- (ii) Find $Var\{\hat{S}(5)\}$ and hence the estimated standard error (8 marks)